USDA Forest Service
Research Paper RM-87

April 1972

Simulating Yields of Southwestern Ponderosa Pine Stands, Including Effects of Dwarf Mistletoe

by
Clifford A. Myers,
Frank G. Hawksworth,
and
Paul C. Lightle

Rocky Mountain Forest and Range Experiment Station
U. S. Department of Agriculture
Forest Service

Abstract

Presents a procedure for computation of yield tables for diseased even-aged stands of ponderosa pine in Arizona and New Mexico. Stand age at time of initial infection by dwarf mistletoe may be varied as desired. Other control variables include stand age at initial thinning, stocking goals, frequency of thinning, and regeneration system. Stand conditions and severity of dwarf mistletoe infestation change with time and in response to intermediate cuttings.
Keywords: Stand yield tables, timber management, forest management, simulation, Arceuthobium vaginatum, Pinus ponderosa.

USDA Forest Service
Research Paper RM-87

April 1972

Simulating Yields of Southwestern Ponderosa Pine Stands, Including Effects of Dwarf Mistletoe

by

Clifford A. Myers, Principal Mensurationist,

Frank G. Hawksworth, Principal Plant Pathologist,

and

Paul C. Lightle, Principal Plant Pathologist

Rocky Mountain Forest and Range Experiment Station[1]

[1]Forest Service, U. S. Department of Agriculture, with central headquarters maintained at Fort Collins, in cooperation with Colorado State University. Lightle is stationed at Albuquerque, in cooperation with the University of New Mexico.

Contents

Simulating Yields of Southwestern Ponderosa Pine Stands, Including Effects of Dwarf Mistletoe

Clifford A. Myers, Frank G. Hawksworth, and Paul C. Lightle

Computation procedures for predicting yields and a computer program SWYLD that prints yield tables are described for even-aged stands of southwestern ponderosa pine (Pinus ponderosa Laws.). Details of field work and computations that apply to healthy stands of ponderosa pine have been presented elsewhere (Myers 1971). Such procedures will not, however, provide some items of information essential for decisionmaking in the Southwest. For practical application, important and predictable causes of reduced growth and mortality should be included in the computations. One such cause is included here.

Dwarf mistletoe (Arceuthobium vaginatum subsp. cryptopodum (Engelm.) Hawks. & Wiens) is widespread in southwestern ponderosa pine forests. Andrews and Daniels (1960) found this dwarf mistletoe on 36 percent of some 2,700 ponderosa pine plots located throughout Arizona and New Mexico. In the Lincoln National Forest and adjacent Mescalero Apache Reservation in southern New Mexico, the infection rate was over 50 percent (Andrews and Daniels 1960, Hawksworth and Lusher 1956).

Several studies have documented the adverse effects of dwarf mistletoe on the height and diameter growth of individual ponderosa pines (Korstian and Long 1922, Sperry 1934, Hawksworth 1961). Such studies do not, however, reveal the total stand loss due to dwarf mistletoe. They do not report mortality, but give information on surviving trees only.

Dwarf mistletoe is one of the four major causes of mortality in southwestern ponderosa pine (Myers and Martin 1963, Pearson 1939). Pearson (1938) found mortality in heavily infested cutover stands to be about five times that in comparable lightly infested or healthy stands. On the Mescalero Apache Reservation, New Mexico, mortality in stands with dwarf mistletoe was nearly twice as high in infested stands as in healthy stands (Hawksworth and Lusher 1956). The differences were most pronounced in cutover areas, where the mortality rate in infested stands was 3.3 times that in mistletoe-free stands.

In the all-aged stands of Grand Canyon National Park, mistletoe-caused mortality and growth reduction offset 10-year basal area growth in moderately and heavily infested stands (Lightle 1966). In pole-sized stands on the Mescalero Reservation, however, basal area declined during a comparable period only in heavily infested stands.

The studies referred to above dealt primarily with the cumulative effects of dwarf mistletoe in unmanaged stands. They do not provide data that can be used directly for yield prediction in managed stands or for comparisons of alternatives. To obtain the necessary pine-mistletoe relationships, procedures used in lodgepole pine stands (Myers, Hawksworth, and Stewart 1971) were repeated in the Southwest.

Information Used

Field and office procedures used to obtain the relationships in program SWYLD were similar to those outlined by Myers (1971) for healthy stands. Additional information on pine-dwarf mistletoe interactions was obtained from several temporary and permanent plots. Most data were from a yield study [2] based on 55 transects located throughout the ponderosa pine forests of Arizona and New Mexico. Additional information was obtained from permanent plots at Fort Valley Experimental Forest and Grand Canyon, Arizona, and the Mescalero Apache Reservation, New Mexico. Derivations of functions that include measures of infection by dwarf mistletoe are described briefly below and in detail elsewhere (Myers et al. 1971).

Basal area and other per-acre values, average stand diameter, and site index (Meyer 1938) are used as dependent and independent variables to obtain the prediction equations used in program SWYLD (appendix 1). The equations shown as FORTRAN statements in the program listing contain only significant independent variables. They indicate the possible appearance of similar functions for other species or localities.

Items computed from field data and uses made of them in SWYLD are as follows:

[2] *Hawksworth, F. G., P. C. Lightle, and T. E. Hinds. Effects of dwarf mistletoe on growth and yields of ponderosa pine. (Manuscript in preparation at Rocky Mt. Forest and Range Exp. Stn.)*

1. Equations to estimate mortality in healthy (OUT) and diseased (DIE) stands are computed from density, mortality, and other data.

2. Prediction equations for height (HTSO) are determined from healthy stands with densities within the range of possible management goals. Infected plots provide data used to derive the equation for reduction in height growth due to disease (PCT).

3. Initial average diameters and other variables from healthy stands are used to obtain the equation for average d.b.h. after 10 years (DBHO). Data from diseased stands provide the equation for reduction in diameter growth due to dwarf mistletoe (TEM). Average stand diameter is the diameter of the tree of average basal area.

4. Cubic- and board-foot volumes per acre are computed from tree volume equations (Myers 1963). Total cubic volumes then provide equations for stand volume in cubic feet (TOTO and TOTT). Total volumes plus merchantable cubic- and board-foot volumes are used to obtain equations for the volume conversion factors (FCTR and PROD) computed by subroutine SWVOL.

5. Several prediction equations are used to obtain dwarf mistletoe ratings (DMR) in SWYLD. One equation for DMR predicts the initial rating if the stand has never been thinned. Other equations for DMR predict the current rating as an increase from a past value. An expected post-thinning rating (DMRT) is computed if infection index is not so high (3.0 or greater) as to make thinning impractical, and if the stand has not already been thinned from above. An equation in subroutine SWCUT2 then predicts the percentage of trees to be removed by thinning from above (REDT) to obtain the expected rating. For subsequent thinnings, DMRT is computed from intensity of thinning and rating prior to thinning.

   Computation of ratings by SWYLD begins with use of the variable START. This is the average of the tree ages when each part of the stand is first infected. It is not the age when the first tree in the stand is infected.

6. Thinning intensity in healthy stands, or in stands to be thinned from below, is based on a relationship between d.b.h. and basal area. Basis for the computations is given in the following tabulation:

Average stand d.b.h. after thinning (Inches)	Basal area per acre (Sq. ft.)
2.0	12.1
2.5	17.9
3.0	23.7
3.5	29.5
4.0	35.2
4.5	41.0
5.0	46.8
5.5	51.8
6.0	56.6
6.5	61.2
7.0	65.4
7.5	69.2
8.0	72.5
8.5	75.3
9.0	77.5
9.5	79.1
10.0+	80.0

These values, SQFT in subroutine SWCUT1 and SWCUT3, represent one possible series of densities that could be used to guide successive thinnings. The growing stock level shown above is 80; reserve basal area remains constant at 80 square feet after stand d.b.h. reaches 10.0 inches. Other stocking levels are named the same way. For example, level 100 means that reserve basal area will be 100 square feet when d.b.h. is 10.0 inches or larger. Basal area for level 100 and diameters smaller than 10.0 inches are obtained by multiplying each basal area of level 80 by the amount 100/80. Values for any stocking level, THIN or DLEV in SWYLD, are computed similarly.

Equations for DBHP in subroutine SWCUT1 and SWCUT3 also describe the tabulated values. In this case, diameter is estimated when basal area and the desired stocking level are known. Variables BREAK and BUST indicate points where the relationship of diameter on basal area has been broken into segments for convenience in regression analysis.

Growing stock levels to be left after thinning from below are indicated by assigning values to THIN and DSTY on data card type 4, as shown in the listing of Order and Contents of the Data Deck. Each assigned value is a growing stock level or the basal

area left when d.b.h. after thinning is 10.0 inches or greater.

7. Equations for DBHE (used as DBHT) in SWCUT1 and SWCUT3 and for ADDHT in the main routine are derived from data obtained in a variety of thinned stands. Thinnings could also be simulated on a computer to obtain data for the DBHE and ADDHT equations (Myers 1971).
8. Values for AGEO, DBHO, and DENO on data card type 4 are obtained by examining numerous young stands. Average d.b.h. at various ages is determined for each site class and for each of several levels of stand density. These data are gathered by users of the program to partially describe their management objectives.

Description of Program SWYLD

Program SWYLD consists of a main program and four subroutine subprograms. The main program performs most computations and writes the yield tables. Three subroutines compute average stand d.b.h. and stand density after thinning. The fourth subroutine computes factors that are used in the main program to convert total cubic feet to other units.

Operations performed by each routine are identified by the comment statements of the source program (appendix 1). Initial stand conditions and values of several control variables are read into computer memory in the order and format given in the tabulation of Order and Contents of the Data Deck. Zero punches in any data card except card type 5 will cause control to move to the end of the program, a diagnostic message to be printed, and termination of the job. The number of yield tables computed and printed is determined by the values assigned NTSTS on card type 1 and MIX on card type 3. NTSTS is the number of sets of tables to be produced. MIX is the number of tables in a set or the number of growing stock levels (DLEV) tested.

Order and Contents of the Data Deck

Card type	Number of cards	Variable name	Columns	Format	Description of variable
1	1	NTSTS	1-4	I4	Number of tests per batch. The number of sets of yield tables to be produced.
2	1	COMCU	1-8	F8.3	Minimum cut in merchantable cubic feet to be included in total yields. Must be at least 1.0.
		COMBF	9-16	F8.3	Minimum cut in board feet to be included in total yields. Must be at least 1.0.
3	1 per test	JCYCL	1-4	I4	Interval between intermediate cuts. A multiple of RINT.
		MIX	5-8	I4	Number of stocking levels or values of DLEV to be examined in one test.
4	1 per test	AGEO	1-8	F8.3	Initial age to be shown in a yield table. Stand age when first thinning occurs.
		DBHO	9-16	F8.3	Average stand d.b.h. just prior to initial thinning at stand age AGEO.
		DENO	17-24	F8.3	Number of trees per acre just prior to initial thinning at stand age AGEO.

Card type	Number of cards	Variable name	Columns	Format	Description of variable
		DSTY	25-32	F8.3	Lowest growing stock level for intermediate cuts after initial thinning. Level will increase by 10 as many times as specified by MIX on card type 3.
		RINT	33-40	F8.3	Number of years for which growth and infection equations make one projection of growth or change. Value is 10.0 for the equations given in appendix 1.
		SITE	41-48	F8.3	Site index on which the set of yield tables is to be based.
		THIN	49-56	F8.3	Growing stock level for initial thinning at age AGEO. May equal DLEV.
		START	57-64	F8.3	Stand age at which dwarf mistletoe infection begins. Never enter zero. Enter number larger than largest REGN(I) if infection will not occur during the rotation.
5	1 per test	REGN(1)	1-8	F8.3	Stand age at which first regeneration cut will occur. Must never be zero or blank, as this is rotation length for clearcutting.
		VLLV(1)	9-16	F8.3	Percentage of previous DLEV to be left at age REGN(1). Will be zero with clearcutting. Enter as a decimal.
		INVL(1)	17-24	F8.3	New interval between cuts in effect after age REGN-(1). Will be zero with clearcutting.
		REGN(2)	25-32	F8.3	Stand age at which second regeneration cut, if any, will occur. Removal of seed trees or second cut of shelterwood.
		VLLV(2)	33-40	F8.3	Percentage of previous DLEV, including effect of VLLV(1), to be left at age REGN(2). May be zero. Enter as a decimal.
		INVL(2)	41-48	F8.3	New interval between cuts in effect after age REGN-(2). May be zero.
		REGN(3)	49-56	F8.3	Stand age at which third regeneration cut, if any, will occur. Final cut of 3-cut shelterwood.

Subsequent operations are performed in the following order:

1. Computation of average height, basal area, volume, and mistletoe rating just prior to initial thinning.

2. Change of interval between cuttings and of residual stand density if a regeneration cut is due and if changes are needed. Entries on data card type 5 control the changes. If the stand is to be clearcut, stand age at time of clearcutting or REGN(1) is the only entry needed. Seed-tree cutting requires that values for all items to and including REGN(2) be punched in card type 5. REGN-(1) is stand age at first regeneration cutting and REGN(2) is age of the seed trees when they are removed. The interval between these two cuttings is INVL(1). Up to three regeneration cuttings are possible with the shelterwood system. Stand age at final cut will be REGN(2) for two-cut shelterwood and REGN(3) for three-cut shelterwood. If a regeneration cut is scheduled, it will be made in the same steps as described below for thinnings.

3. Thinning and computation of the new mistletoe rating after thinning, if the current rating is below 3.0. If thinning is possible, subroutines compute the new stand density and average d.b.h., as explained below. The main program then computes the new average stand height.

4. Computation of post-thinning volumes.

5. Computation of amounts removed by thinning and of values describing conditions before and after thinning.

6. Printing of before- and after-thinning values in the yield table.

7. Advancement of d.b.h., height, stand density, and mistletoe rating one prediction period and computation of new volumes. Mistletoe rating is computed as an increase from a previous value or as a projection from initial infection, depending upon whether or not thinning has occurred since infection.

8. Printing of values appropriate to the stand age, if thinning is not scheduled.

9. Rethinning, if thinning is scheduled, by return of program control to the operations described in item 2.

10. Repetition of operations described in items 2 to 9, inclusive, until stand age reaches the limit set by the largest value of REGN-(I) on data card type 5.

Only one thinning in diseased stands will be from above, as simulated by SWCUT2. Subsequent thinnings in diseased stands will increase average d.b.h. and height, but by lesser amounts than in healthy stands where the smaller trees make up a larger percentage of those removed. This effect has been observed in subsequent thinnings of actual stands, and is simulated by SWCUT3.

Subroutines SWCUT1 and SWCUT3 compute average stand d.b.h. after thinnings that remove many of the smaller trees and thus increase average stand diameter and height. Successive percentages of trees to be retained (PRET) are tested until the relationship between d.b.h., basal area, and number of trees is mathematically correct and d.b.h. and basal area agree with the growing stock level specified by THIN or DLEV. Two major loops are provided in the subroutines because two equations are needed for estimating post-thinning d.b.h. (DBHE).

Subroutine SWCUT2 uses thinning standards based on the goals of sanitation thinning, not on THIN or DLEV. The reduced infection rating to be attained (DMRT) is computed by the main program as a function of average stand d.b.h., as follows:

D.b.h. (Inches)	Rating
2	0
4	0.5
6	1.0
8	1.5
10	2.0

SWCUT2 then computes the reduction in stand density (REDT) needed to attain this goal, based on d.b.h. and rating just prior to thinning. D.b.h. after thinning (DBHT) can then be determined directly with the same equations as for DBHE in SWCUT1. Successive approximations are unnecessary because percentage of trees to be retained (PRET) is known before DBHE (as DBHT) is computed.

Replacement of several statements will modify the program for other utilization standards, species, or regions. Replacements needed are:

1. Statements for SQFT, DBHP, BREAK, BUST, and related computations that contain the ratio of DLEV or THIN to 80.0, if desired. This change is needed if standards for reserve stands in SWCUT1 and SWCUT3 will be different from those shown in the tabulation of the previous section.

2. Statements from TOTO and TOTT, to make cubic volumes per acre correct for the species and tree volume equations selected.

3. Statements for FCTR and PROD in subroutine SWVOL that are correct for the species, tree volume equations, and utilization standards selected.

4. Statements for HTSO, ADDHT, and PCT so that height growth, changes in height due to thinning, and reductions in growth caused by dwarf mistletoe will be appropriate for the species.

5. Statements for or that include DMR, DMRT, and REDT; to show correct relationship for the host-parasite interaction being simulated.

6. Statement for DBHO, based on a growth study in healthy stands of the species of interest, and a statement for TEM to compute the effect of mistletoe on diameter growth.

7. Statements for DBHE in subroutine SWCUT1 and SWCUT3 and for DBHT in SWCUT2 that apply to the species of interest.

8. Statements that describe periodic losses in numbers of trees in both healthy (OUT) and diseased (DIE) stands.

9. Table headings.

A Sample Problem

The following sample problem provides additional description of the data deck and of the output (appendix 2). It can also serve as a test problem to check accuracy of punching of the source deck and to test compatibility with local equipment.

Assume a forest composed of even-aged stands of ponderosa pine that differ in degree of infection by dwarf mistletoe. Problems to be solved by the manager of such a forest include:

1. What growth can be expected in healthy stands of known site quality for various combinations of thinning frequency and intensity?

2. How is this growth affected by various degrees of dwarf mistletoe infection and time of initial sanitation thinning?

3. On the basis of potential yields of each stand, is thinning, replacement, or no treatment appropriate for the stand at this time?

4. Does each treatment decision appear appropriate when impacts on other forest resources are considered?

Answers that contribute to good land management cannot be obtained unless all numerical results can be estimated to a useful degree of accuracy. Program SWYLD provides such estimates for trees and dwarf mistletoe. In the sample problem, yields of healthy stands are compared with those initially infected at age 10. Other variables remain constant for both tests except for stand conditions at initial thinning and intensity of thinning. No scheduled thinning will be performed if the dwarf mistletoe rating is 3.0 or greater. Regeneration will be by two-cut shelterwood with 20 years between removal and final cut. The data deck contains the following values:

NTSTS - 3, for healthy stands (test 1), diseased and thinned at age 30 (test 2), and diseased and first thinned at age 50 (test 3).
COMCU - 320.0 cubic feet, minimum commercial cubic-foot cut.
COMBF - 1500.0 board feet, minimum commercial board-foot cut.
JCYCL - 20 years.
MIX - 3, or 3 intensities of thinning will be examined in each test.
AGEO - 30.0 years for two tests and 50.0 years for the third.
DBHO - 4.8 inches for two tests, 6.2 inches for the third.
DENO - 950.0 trees for two tests, 575.0 trees for the third.
DSTY - 80.0, lowest subsequent thinning level of the 3 to be examined.
RINT - 10.0 years, prediction period of the equations.
SITE - 70.0 feet, base 100 years.
THIN - 100.0 level for initial thinning.
START - 200.0, 10.0, and 10.0 years on type 3 data cards of test 1, test 2, and test 3, respectively. Any number larger than the largest value of REGN(I) could replace the 200.0 shown.
REGN(1) - 110.0 years, stand age at time of removal cut.
VLLV(1) - 50.0 percent, read as a decimal, amount of previous residual basal area to be left as shelterwood.
INVL(1) - 20 years, interval between removal and final cuts.
REGN(2) - 130.0 years, stand age at time of final cut.

These values will provide data for comparison of the differences in yields between healthy and diseased stands, and between different types of diseased stands. Values must be read from data cards assembled in the order:

(1) type 1, (2) type 2, (3) type 3 of test 1, (4) type 4 of test 1, (5) type 5 of test 1, (6) type 3 of test 2, (7) type 4 of test 2, (8) type 5 of test 2, (9) type 3 of test 3, (10) type 4 of test 3, and (11) type 5 of test 3. Additional tests could be made to examine the effect of variations in thinning intensity or in any other control variable.

Tables produced by SWYLD can be used in many ways to assist in decisionmaking. For many purposes, yields of healthy stands will be desired so that long-range goals can be determined. Yields, numbers of noncommercial cuts, number of scheduled cuts that cannot be made, and size of the average tree are some of the values produced. Money yields and rates earned can be computed if necessary data on costs and stumpage values are available. Stand ages at culmination of mean annual increment, and rates earned can help the manager determine suitable rotations for his working groups.

A manager examining the tables in appendix 2, for example, might reach the following conclusions:

1. A stand initially infested at age 10 and then left untreated for 40 years will produce very little merchantable volume by age 130. The stand is already too heavily infested by age 50 for subsequent treatment to produce improvement.

2. A stand infested by dwarf mistletoe at age 10 but thinned at 20-year intervals beginning at age 30, can produce only a small volume of useful wood products. Yields, including thinnings, would be much less than those from healthy stands with the same site index and thinned according to the same schedule. Also, actual yields of diseased stands would be less than the computed volumes because no reduction has been made for amounts of wood lost due to pitch or distorted grain.

3. In healthy stands, largest yields would be produced with relatively light thinnings, such as to level 100. Comparing yields in thinned stands with and without dwarf mistletoe, diseased stands produce about a third of the merchantable cubic- and board-foot volumes of healthy stands.

Literature Cited

Andrews, S. R., and J. P. Daniels.
1960. A survey of dwarfmistletoes in Arizona and New Mexico. U. S. Dep. Agr., Forest Serv., Rocky Mt. Forest and Range Exp. Stn., Stn. Pap. 49, 17 p. Fort Collins, Colo.

Hawksworth, F. G.
1961. Dwarfmistletoe of ponderosa pine in the Southwest. U. S. Dep. Agr. Tech. Bull. 1246, 112 p.

_____ and A. A. Lusher.
1956. Dwarfmistletoe survey and control on the Mescalero Apache Reservation, New Mexico. J. Forest. 54: 384-390.

Korstian, C. F., and W. H. Long.
1922. The western yellow pine mistletoe: effects on growth and suggestions for control. U. S. Dep. Agr. Bull. 1112, 35 p.

Lightle, P. C.
1966. Dwarf mistletoe reduces basal area growth in ponderosa pine in the Southwest. (Abstr.) Phytopathology 56: 886-887.

Meyer, Walter H.
1938. Yield of even-aged stands of ponderosa pine. U. S. Dep. Agr. Tech. Bull. 630, 59 p.

Myers, Clifford A.
1963. Volume, taper, and related tables for southwestern ponderosa pine. U. S. Forest Serv. Res. Pap. RM-2, 24 p. Rocky Mt. Forest and Range Exp. Stn., Fort Collins, Colo.

_____
1971. Field and computer procedures for managed-stand yield tables. USDA Forest Serv. Res. Pap. RM-79, 24 p. Rocky Mt. Forest and Range Exp. Stn. Fort Collins, Colo.

_____, F.G. Hawksworth, and J.L. Stewart.
1971. Simulating yields in managed, dwarf mistletoe-infested lodgepole pine stands. USDA Forest Serv. Res. Pap. RM-72, 15 p. Rocky Mt. Forest and Range Exp. Stn., Fort Collins, Colo.

_____, and Edward C. Martin.
1963. Mortality of southwestern ponderosa pine sawtimber after second partial harvest. J. Forest. 61: 128-130.

Pearson, G. A.
1938. Lighter cuts and larger yields in ponderosa pine. J. Forest. 36: 779-789.

_____
1939. Mortality in cutover stands of ponderosa pine. J. Forest. 37: 383-387.

Sperry, O. E.
1934. The rate of growth of the ponderosa pine in Estes Park, Colorado. Torrey Bot. Club Bull. 61: 19-34.

APPENDIX 1
Listing of Program SWYLD

```
      PROGRAM SWYLO
     1(INPUT,OUTPUT,TAPE5=INPUT,TAPE6=OUTPUT)
C
C TO COMPUTE AND PRINT YIELD TABLES FOR EVEN-AGED STANDS OF SOUTHWESTERN
C PONDERDSA PINE WITH DR WITHDUT INFECTION BY DWARF MISTLETOE.
C
C DEFINITIONS OF VARIABLES.
C
C     ADDHT = INCREASE OR DECREASE IN AVERAGE STAND HEIGHT BY THINNING.
C     AGED = INITIAL AGE IN YIELD TABLE.
C     BASC = BASAL AREA CUT PER ACRE.
C     BASO = BASAL AREA PER ACRE BEFORE THINNING.
C     BAST = BASAL AREA PER ACRE AFTER THINNING.
C     BDFC = BOARD FEET CUT PER ACRE.
C     BDFO = BOARD FEET PER ACRE BEFORE THINNING.
C     BDFT = BOARD FEET PER ACRE AFTER THINNING.
C     CFMC = MERCHANTABLE CU. FT. CUT PER ACRE.
C     CFMO = MERCH. CU. FT. PER ACRE BEFORE THINNING.
C     CFMT = MERCH. CU. FT. PER ACRE AFTER THINNING.
C     COMBF = MINIMUM COMMERCIAL CUT, BOARD FEET.
C     COMCU = MINIMUM COMMERCIAL CUT, CU. FT.
C     OBHO = AVERAGE STAND D.B.H. BEFORE THINNING.
C     OBHT = AVERAGE STAND D.B.H. AFTER THINNING.
C     DENC = TREES CUT PER ACRE.
C     DEND = TREES PER ACRE BEFORE THINNING.
C     DENT = TREES PER ACRE AFTER THINNING.
C     DIE = TREES LOST IN DISEASED STANDS IN 1D YEARS, IN PERCENT.
C     DLEV = GROWING STDCK LEVEL FOR INTERMEDIATE CUTS AFTER THE FIRST.
C     OMR = DWARF MISTLETOE INFECTION RATING.
C     DMRT = MAXIMUM INFECTION EXPECTED IN STANDS AFTER THINNING. GOAL
C          FOR STANDS NOT ALREADY BEYOND DMR OF 3.D.
C     DSTY = LOWEST VALUE OF DLEV USED IN A TEST.
C     HTSD = TREE HEIGHT BEFORE THINNING.
C     HTST = TREE HEIGHT AFTER THINNING.
C     INVL(I) = NEW CUTTING CYCLE AFTER REGENERATION CUT I.
C     JCYCL = INTERVAL BETWEEN INTERMEDIATE CUTS.
C     JSBD = SUM OF BOARD FEET FROM ALL CUTS WITH YIELD OF COMBF OR
C          LARGER.
C     JSMC = SUM OF MERCH. CU. FT. FROM ALL CUTS WITH YIELD OF COMCU
C          OR LARGER.
C     JSTF = SUM OF TOTAL CU. FT. FROM ALL CUTS.
C     KSTEP = INDICATOR WITH VALUE OF ONE IF CURRENT THINNING IS FROM
C          BELOW AND TWO IF CURRENT THINNING IS FROM ABOVE.
C     KTR = INDICATOR WITH VALUE GREATER THAN ZERO IF A SCHEDULED
C          THINNING HAS BEEN SKIPPED BECAUSE MISTLETOE INDEX IS TOO HIGH
C          OR BECAUSE STAND IS ALREADY TO SPECIFIED STOCKING.
C     MIX = NUMBER OF STOCKING LEVELS EXAMINED PER TEST.
C     NFLAG = INDICATOR WITH VALUE GREATER THAN ZERO IF A THINNING FROM
C          ABOVE HAS BEEN MADE AT ANY TIME.
C     NTSTS = NUMBER OF TESTS PER BATCH.
C     OUT = PERCENT MORTALITY IN HEALTHY STANDS.
C     PCT = PERIODIC HEIGHT INCREASE IN INFESTED STAND, AS A PERCENTAGE
C          OF THE INCREASE IN COMPARABLE HEALTHY STANDS.
C     PRET = PERCENTAGE OF TREES RETAINED AFTER THINNING.
C     REDT = PERCENTAGE REDUCTION IN NUMBER OF TREES WHEN DMR IS
C          REDUCED TO DMRT BY THINNING.
C     REGN(I) = STAND AGE WHEN REGENERATION CUT I OCCURS.
C     RINT = NUMBER OF YEARS FOR WHICH A SINGLE PROJECTION IS MADE.
C     ROTA = FINAL AGE IN YIELD TABLE.
C     SITE = SITE INDEX.
C     START = STAND AGE AT TIME OF INITIAL INFECTION.
C     TEM = PERIODIC D.B.H. INCREASE IN INFESTED STAND, AS A PERCENTAGE
C          OF THE INCREASE IN COMPARABLE HEALTHY STANDS.
C     THIN = GROWING STDCK LEVEL FOR INITIAL THINNING.
C     TOTC = TOTAL CUBIC FEET CUT PER ACRE.
C     TOTD = TOTAL CUBIC FEET PER ACRE BEFORE THINNING.
C     TOTT = TOTAL CUBIC FEET PER ACRE AFTER THINNING.
C     VLLV(I) = PERCENT OF PREVIOUS OLEV TO BE LEFT AT REGN(I), ENTERED
C          AS A DECIMAL.
C
      COMMON BA,BAST,OBHO,OBHT,DENO,OMR,OMRT,FCTR,PRET,PRDO,REST,VDM
      DIMENSION VAR(11),TEMH(2),INVL(3),REGN(3),VLLV(3)
C
      DO 1 J=1,11
    1 VAR(J) = 0.0
C
C READ NUMBER OF TESTS PER BATCH FROM CARD TYPE ONE.
C
      READ (5,5) NTSTS
    5 FORMAT (I4)
      IF(NTSTS .LE. 0) GO TO 470
C
C READ MINIMUM COMMERCIAL CUTS FOR COMPUTATION OF COLUMN TOTALS FROM
C CARD TYPE TWO.
C
      READ (5,10) COMCU,COMBF
   10 FORMAT (10F8.3)
      VAR(9) = COMBF
      VAR(10) = COMCU
C
C EXECUTE PROGRAM ONCE FOR EACH SET OF INITIAL VALUES OF INTEREST.
C
      DO 460 I=1,NTSTS
      JTEM = 0
C
C READ CUTTING INTERVAL AND LEVELS PER TEST FROM CARD TYPE THREE.
C
      READ (5,15) JCYCL,MIX
   15 FORMAT (2I4)
      IF(JCYCL .LE. 0 .OR. MIX .LE. 0) GO TO 470
      JTEM = JCYCL
C
C READ INITIAL STAND VALUES FROM CARD TYPE FOUR.
C
      READ (5,20) AGED,OBHO,DEND,OSTY,RINT,SITE,THIN,START
      VAR(1) = AGED
      VAR(2) = DBHO
      VAR(3) = DENO
      VAR(4) = DSTY
      VAR(5) = RINT
      VAR(6) = SITE
      VAR(7) = THIN
      VAR(8) = START
C
C READ SILVICULTURAL CONTROLS FROM CARD TYPE FIVE.
C
      READ (5,20)REGN(1),VLLV(1),INVL(1),REGN(2),VLLV(2),INVL(2),REGN(3)
      VAR(11) = REGN(1)
      DO 20 L=1,11
      IF(VAR(L) .LE. 0.0) GO TO 470
   20 CONTINUE
      OLEV = 0.0
      DO 35 NA=1,3
      L = 4 - NA
      IF(REGN(L) .EQ. 0.0) GO TO 35
      ROTA = REGN(L)
      GO TO 40
   35 CONTINUE
C
C PROVIDE FOR SEVERAL GROWING STOCK LEVELS PER TEST.
C
   40 DO 460 M=1,MIX
      A = M
      ADDHT = 0.0
      BDFO = 0.0
      BDFT = 0.0
      CFMO = 0.0
      CFMT = 0.0
      OMR = 0.0
      DMRT = 0.0
      HTCUM = 0.0
      JSBD = 0
      JSMC = 0
      JSTF = 0
      KSTEP = 1
      KTR = 0
      NFLAG = 0
      TIME = 0.0
      DLEV = (OSTY + (A * 10.0)) - 10.0
      BASO = DENO * 0.0054542 * DBHO * DBHO
C
C COMPUTE CURRENT DWARF MISTLETOE RATING, UNTHINNED STANDS.
C
      TIME = AGEO - START
      IF(TIME .LE. 0.0) GO TO 45
      OMR = 0.06533 * TIME + 0.03616 * SITE - 1.4486
      IF(DMR .LT. 0.0) DMR = 0.0
      IF(DMR .GT. 6.0) OMR = 6.0
C
C OBTAIN AVERAGE HEIGHT AND VOLUMES PER ACRE.
C
   45 IF(AGED .GT. 55.0) GO TO 50
      HTSD = 0.01441 * AGEO * SITE - 0.12162 * AGED - 1.50953
      GO TO 55
   50 HTSD = 0.59947 - 61.5019 / AGEO + 0.80522 * ALOG10(SITE) + 20.5252
     1B * ALOG10(SITE) / AGEO
      HTSD = 10.0 ** HTSO
   55 PCT = 1.073 - 0.0367 * DMR
      IF(PCT .GT. 1.0) PCT = 1.0
      HTSO = HTSO * PCT
C
C COMPUTE TOTAL CU. FT. AND CONVERT TO OTHER UNITS.
C
      O2H = OBHO * OBHO * HTSO
      IF(O2H .GT. 5000.0) GO TO 60
      TOTO = (0.53313 + 0.00033 * BASO + 0.00179 * O2H) * DENO
      GO TO 65
   60 TOTO = (0.00237 * BASO + 0.00211 * O2H - 1.09356) * OENO
   65 IF(OBHO .LT. 5.0) GO TO 70
      VOM = OBHO
      BA = BASO
      CALL SWVOL
      BOFO = TOTO * PROO
      CFMO = TOTO * FCTR
   70 REST = THIN
C
C ENTER LOOP FOR REMAINING COMPUTATIONS AND PRINTOUT.
C
      DO 355 K=1,100
C
C CHANGE STANDARDS IF A REGENERATION CUT IS DUE.
C
   90 IF(AGEO .GE. ROTA) GO TO 165
      IF(AGEO .LT. REGN(I)) GO TO 108
      IF(AGEO .NE. REGN(1)) GO TO 95
      OLEV = OLEV * VLLV(1)
      REST = OLEV
      JCYCL = INVL(1)
      GO TO 105
   95 IF(AGEO .NE. REGN(2)) GO TO 100
      OLEV = OLEV * VLLV(2)
      REST = OLEV
```

```
      JCYCL = INVL(2)
      GO TO 105
  100 IF(AGED .NE. REGN(3)) GO TO 105
      OLEV = OLEV * VLLV(3)
      REST = OLEV
      JCYCL = INVL(3)
C
C INCREASE D.B.H. BY THINNING AND COMPUTE POST-THINNING VALUES.
C
  105 IF(AGED .EQ. REGN(1) .OR. AGFO .EQ. REGN(2)) GO TO 123
  108 IF(OMR .LT. 3.0) GO TO 110
      BAST = BASO
      OBHT = OBHO
      OMRT = OMR
      HTST = HTSO
      KTR = 1
      GO TO 150
  110 IF(DMR .EQ. 0.0) GO TO 120
      IF(NFLAG .GT. 0) GO TO 115
      OMRT = 0.25 * OBHO - 0.50
      IF(OMRT .LT. 0.0) OMRT = 0.0
      IF(OMRT .GE. DMR) GO TO 115
      CALL SWCUT2
      NFLAG = 1
      KSTEP = 2
      GO TO 125
  115 CALL SWCUT3
      KSTEP = 1
      OMRT = OMR + 0.0279 * PRET - 2.79
      GO TO 125
  120 OMRT = OMR
      CALL SWCUT1
      KSTEP = 1
      GO TO 125
  123 CALL SWCUTI
      KSTEP = 1
      OMRT = DMR + 0.0279 * PRET - 2.79
      IF(OMRT .GT. 6.0) OMRT = 6.0
  125 IF(BAST .LT. BASD) GO TO 130
      BAST = BASO
      OBHT = OBHO
      OMRT = OMR
      HTST = HTSO
      KTR = 1
      GO TO 150
C
C COMPUTE HEIGHT AND VOLUMES AFTER THINNING.
C
  130 GO TO (135,140),KSTEP
  135 AOOHT = 7.64833 - 3.82286 * ALOG10(PRET)
      GO TO 145
  140 AOOHT = 3.4177 * ALOG10(PRET) - 8.68863 / BAST - 7.22001
  145 HTCUM = HTCUM + AOOHT
      HTST = HTSO + AOOHT
  150 JOENT = (BAST / (0.0054542 * OBHT * OBHT)) + 0.5
      OENT = JOENT
      BAST = 0.0054542 * OBHT * OBHT * OENT
      O2H = OBHT * OBHT * HTST
      IF(O2H .GT. 5000.0) GO TO 155
      TOTT = (0.53313 + 0.00033 * BAST + 0.00179 * O2H) * OENT
      GO TO 160
  155 TOTT = (0.00237 * BAST + 0.00211 * O2H - 1.09356) * OENT
C
C CONVERT TOTAL CU. FT. TO OTHER UNITS.
C
  160 IF(OBHT .LT. 5.0) GO TO 165
      VOM = OBHT
      BA = BAST
      CALL SWVOL
      BOFT = TOTT * PROO
      CFMT = TOTT * FCTR
C
C CHANGE MODE AND ROUND OFF FOR PRINTING.
C
  165 JAGED = AGED
      JSITE = SITE
      JOEND = OENO + 0.5
      JHTSD = HTSO + 0.5
      JTOTO = (TOTO * 0.1) + 0.5
      JTOTO = JTOTO * 10
      JBASD = BASO + 0.5
      JCFMO = (CFMO * 0.1) + 0.5
      JCFMO = JCFMO * 10
      JBOFO = (BOFO * 0.01) + 0.5
      JBOFO = JBOFO * 100
      JHTST = HTST + 0.5
      JTOTT = (TOTT * 0.1) + 0.5
      JTOTT = JTOTT * 10
      JCFMT = (CFMT * 0.1) + 0.5
      JCFMT = JCFMT * 10
      IF(JCFMT .GT. JCFMO) JCFMO = JCFMT
      JBOFT = (BOFT * 0.01) + 0.5
      JBOFT = JBOFT * 100
      IF(JBOFT .GT. JBOFO) JBOFO = JBOFT
      JBAST = BAST + 0.5
      JDENC = JOENO - JDENT
      JBASC = JBASO - JBAST
      JTOTC = JTOTO - JTOTT
      JCFMC = JCFMO - JCFMT
      IF(JCFMC .LE. 0) JCFMC = 0
      JBOFC = JBOFO - JBOFT
      IF(JBOFC .LE. 0) JBOFC = 0
C
C SUM PERIODIC CUTS FOR LAST LINE OF YIELD TABLE.
C
      IF(AGED .GE. ROTA) GO TO 190
      JSTF = JSTF + JTOTC
      CFMC = JCFMC
      IF(CFMC .LT. COMCU) GO TO 170
      JSMC = JSMC + JCFMC
  170 BOFC = JBOFC
      IF(BOFC .LT. COMBF) GO TO 190
      JSBO = JSBO + JBOFC
C
C WRITE HEADINGS FOR YIELD TABLE.
C
  190 IF(K .GE. 2) GO TO 220
      WRITE (6,195) JSITE,THIN,OLEV
  195 FORMAT (1H1,///,39X,53HYIELDS PER ACRE OF EVEN-AGED STANDS OF POND
     1EROSA PINE/1H ,57X,11HSITE INDEX ,I3/1H ,3BX,29HTHINNING INTENSITY
     2- INITIAL- ,F5.0,2X,12HSUBSEQUENT- ,F5.0)
      WRITE (6,200)
  200 FORMAT (1HO,25X,3BHENTIRE STAND BEFORE AND AFTER THINNING,28X,26HP
     1ERIODIC INTERMEDIATE CUTS)
      WRITE (6,205)
  205 FORMAT (1HO,9X,5HSTAND,10X,5HBASAL,3X,7HAVERAGE,2X,7HAVERAGE,3X,5H
     1TOTAL,3X,9HMERCHANT-,3X,9HSAWTIMBER,9X,5HBASAL,4X,5HTOTAL,3X,9HMER
     2CHANT-,3X,9HSAWTIMBER)
      WRITE (6,210)
  210 FORMAT (1H ,10X,3HAGE,4X,5HTREES,3X,4HAREA,4X,6HD.B.H.,3X,6HHEIGHT
     1,2X,6HVOLUME,2X,11HABLE VOLUME,4X,6HVOLUME,3X,5HTREES,3X,4HAREA,3X
     2,6HVOLUME,2X,11HABLE VOLUME,4X,6HVOLUME)
      WRITE (6,215)
  215 FORMAT (1H ,8X,7H(YEARS),3X,3HNO.,3X,6HSQ.FT.,4X,3HIN.,6X,3HFT.,4X
     1,6HCU.FT.,5X,6HCU.FT.,6X,6HBD.FT.,4X,3HNO.,3X,6HSQ.FT.,2X,6HCU.FT.
     2,5X,6HCU.FT.,6X,6HBO.FT.)
C
C WRITE TABLE ENTRIES OF DIAMETER, VOLUMES, ETC.
C
  220 WRITE (6,225) JAGED,JOENO,JBASO,OBHO,JHTSO,JTOTO,JCFMO,JBOFO
  225 FORMAT (1HO,9X,I4,4X,I5,2X,I4,5X,F5.1,5X,I3,4X,I5,6X,I5,6X,I6)
      IF(AGED .GE. ROTA) GO TO 370
      WRITE (6,230) JAGED,JOENT,JBAST,OBHT,JHTST,JTOTT,JCFMT,JBOFT,JDENC
     1,JBASC,JTOTC,JCFMC,JBOFC
  230 FORMAT (1H ,9X,I4,4X,I5,2X,I4,5X,F5.1,5X,I3,4X,I5,6X,I5,6X,I6,4X,I
     15,3X,I3,5X,I4,6X,I4,8X,I5)
C
C COMPUTE VALUES FOR EACH PERIOD. THIN AS SPECIFIED.
C
      IRINT = RINT
      IK = JCYCL / IRINT
      DO 345 L=1,IK
      AGEO = AGED + RINT
      IF(AGED .GT. ROTA) GO TO 370
C
C COMPUTE CURRENT DWARF MISTLETOE RATING.
C
      TIME = AGEO - START
      IF(OMR .GT. 0.0) GO TO 250
      IF(TIME .LE. 0.0) GO TO 265
      OMR = 0.06533 * TIME + 0.03616 * SITE - 1.4486
      GO TO 260
  250 IF(OMRT .LE. 1.0) GO TO 255
      OMR = OMR + 0.065 * RINT
      GO TO 260
  255 OMR = OMRT + (0.03 + 0.038 * OMRT) * RINT
      IF(L .LE. 2) GO TO 260
      OMR = OMR + 0.065 * RINT
  260 IF(OMR .LT. 0.0) OMR = 0.0
      IF(OMR .GT. 6.0) OMR = 6.0
C
C COMPUTE NEW D.B.H. BEFORE THINNING AND ROUND OFF TO 0.1 INCH.
C
  265 OBHO = 1.0097 * OBHT + 0.0096 * SITE-(1.5766*ALOG10(BAST))+3.3021
      IF(OMRT .LE. 3.5) GO TO 270
      TEM = (OBHO - OBHT) * (1.0 - (0.056 * OMRT - 0.197))
      OBHO = OBHT + TEM
  270 IOBHO = OBHO * 10.0 + 0.5
      OBHO = IOBHO
      OBHO = OBHO * 0.1
      OIE = 0.0
      IF(OMRT .LT. 1.0) GO TO 273
      OIE = 20.66469 + 4.42271 * OMRT - 0.36374 * SITE + 3.87613 * ALOG1
     10(OENT)
      OIE = OIE * 0.01
      IF(OIE .LT. 0.0) OIE = 0.0
  273 OUT = 0.0
      IF(OBHT .GE. 10.0) GO TO 275
      OUT = 0.00247 + 0.00124 * OBHT + 0.0002B * OBHT * OBHT + 0.0000052
     11 * BAST * BAST - 0.0000905 * OBHT * BAST
      IF(OUT .LT. 0.0) OUT = 0.0
  275 IF(OIE .LT. OUT) OIE = OUT
      JOENO = (OENT * (1.0 - OIE)) + 0.5
      DENO = JOENO
      BASO = OENO * (0.0054542 * DBHO * OBHO)
C
C OBTAIN AVERAGE HEIGHT AND VOLUMES PER ACRE.
C
      DO 300 J=1,2
      LUB = J
      GO TO (280,285),LUB
  280 YARS = AGED
      GO TO 290
  285 YARS = AGEO - RINT
  290 IF(YARS .GT. 55.0) GO TO 295
      TEMH(J) = 0.01441 * YARS * SITE - 0.12162 * YARS - 1.50953
      GO TO 300
  295 TEMH(J) = 0.59947 - 61.5019 / YARS + 0.80522 * ALOG10(SITE) + 20.5
     112528 * ALOG10(SITE) / YARS
      TEMH(J) = 10.0 ** TEMH(J)
  300 CONTINUE
      PCT = 1.0 - 0.0002 * OMRT * OMRT * OMRT
      CHNG = (TEMH(1) - TEMH(2)) * PCT
      HTSO = HTST + CHNG
C
C COMPUTE TOTAL CU. FT. AND CONVERT TO OTHER UNITS.
C
      O2H = OBHO * OBHO * HTSO
      IF(O2H .GT. 5000.0) GO TO 305
      TOTO = (0.53313 + 0.00033 * BASO + 0.00179 * O2H) * OENO
      GO TO 310
  305 TOTO = (0.00237 * BASO + 0.00211 * O2H - 1.09356) * OENO
  310 IF(OBHO .LT. 5.0) GO TO 315
      VOM = OBHO
      BA = BASO
      CALL SWVOL
      BOFO = TOTO * PROO
      CFMO = TOTO * FCTR
C
C TEST IF REGENERATION CUT IS DUE.
C
  315 DO 320 KU=1,3
      IF(AGED .EQ. REGN(KU)) GO TO 90
  320 CONTINUE
C
C CHANGE MODE AND ROUND OFF FOR PRINTING.
C
      IF(L .EQ. IK) GO TO 350
      KOENO = OENO + 0.5
      KAGEO = AGEO
      KHTSO = HTSO + 0.5
      KBASD = BASO + 0.5
      KTOTO = (TOTO * 0.1) + 0.5
      KTOTO = KTOTO * 10
      KCFMO = (CFMO * 0.1) + 0.5
      KCFMO = KCFMO * 10
      KBOFO = (BOFO * 0.01) + 0.5
      KBOFO = KBOFO * 100
C
C WRITE VALUES FOR THE PERIOD IF THINNING IS NOT DUE.
C
      WRITE (6,225) KAGEO,KOENO,KBASO,OBHO,KHTSD,KTOTO,KCFMO,KBOFO
      OBHT = OBHO
      BAST = BASO
      OENT = OENO
      DMRT = OMR
```

```
      HTST = HTSO
  345 CONTINUE
C
C PREPARE TO START LOOP AGAIN FOR NEXT THINNING.
C
  350 REST = DLEV
  355 CONTINUE
C
C ADD FINAL CUTS TO TOTAL YIELDS AND WRITE TOTAL YIELDS.
C
  370 JSTF = JSTF + JTOTO
      CFMD = JCFMO
      IF(CFMO .LT. COMCU) GO TO 375
      JSMC = JSMC + JCFMO
  375 BOFO = JBOFO
      IF(BOFO .LT. COMBF) GO TO 380
      JSBO = JSBO + JBOFO
  380 WRITE (6,385) JSTF,JSMC,JSBO
  385 FORMAT (1HO,/,67X,12HTOTAL YIELDS,20X,I4,6X,I4,8X,I5)
      WRITE (6,390) COMCU,COMBF
  390 FORMAT (1HO,//,11X,44HMINIMUM CUTS FOR INCLUSION IN TOTAL YIELDS--
     1,F6.0,15H CUBIC FEET AND,F7.0,11H BOARD FEET)
      IF(START .GE. ROTA) GO TO 405
      WRITE (6,400) START,OMR,ROTA
  400 FORMAT (1HO,1OX,41HDWARF MISTLETOE INFECTION STARTED AT AGE ,F4.0,
     116H AND RATING WAS ,F5.1,8H AT AGE ,F4.0)
      GO TO 415
  405 WRITE (6,410) ROTA
  410 FORMAT (1HO,1OX,63HDWARF MISTLETOE INFECTION DID NOT OCCUR DURING
     1THE ROTATION OF ,F4.0,7H YEARS.)
  415 IF(KTR .EQ. 0) GO TO 425
      WRITE (6,420)
  420 FORMAT (1HO,1OX,52HNOTE THAT NOT ALL SCHEDULED THINNINGS WERE POSS
     1IBLE.)
  425 WRITE (6,430)
  430 FORMAT (1HO,1OX,6BHMERCH. CU. FT. - TREES 6.0 INCHES D.B.H. AND LA
     1RGER TO 4.0-INCH TOP.)
      WRITE (6,435)
  435 FORMAT (1HO,1OX,6BHBD. FT. - TREES 10.0 INCHES D.B.H. AND LARGER T
     1O VARIABLE TOP LIMIT.)
C
C PREPARE FOR NEXT TABLE OF THE TEST.
C
      AGEO = VAR(1)
      OBHO = VAR(2)
      OENO = VAR(3)
      JCYCL = JTEM
  460 CONTINUE
      GO TO 500
C
C PROGRAM CONTROL GOES HERE IF ANY UNWANTED ZEROS IN DATA DECK.
C
  470 WRITE (6,480)
  480 FORMAT (1H1,///,1OX,64HEXECUTION STOPPED BECAUSE OF NEGATIVE OR ZE
     1RO ITEM ON DATA CARD.)
  500 CALL EXIT
      END
```

```
      SUBROUTINE SWVOL
C
C TO CONVERT TOTAL CU. FT. TO MERCH. CU. FT. AND TO BO. FT.
C
      COMMON BA,BAST,OBHO,OBHT,OENO,OMR,OMRT,FCTR,PRET,PROD,REST,VOM
C
      FCTR = 0.0
      PROD = 0.0
      IF(VOM .LT. 5.0) GO TO 10
C
C OBTAIN CONVERSION FACTORS FOR MERCH. CU. FT. - VOLUMES TO 4.0-INCH TOP
C IN TREES 6.0 INCHES D.B.H. AND LARGER.
C
      IF(VOM .GT. 6.5) GO TO 2
      FCTR = 0.25222 * VOM - 1.01119
      GO TO 6
    2 IF(VOM .GT. 10.0) GO TO 4
      FCTR = 3.02485 - 0.09957 * VOM - 11.35814 / VOM
      GO TO 6
    4 FCTR = 1.03936 - 1.41034 / VOM
    6 IF(VOM .LT. 8.0) GO TO 10
C
C OBTAIN CONVERSION FACTORS FOR BO. FT. - VOLUMES TO VARIABLE TOP IN
C TREES 10.0 INCHES D.B.H. AND LARGER.
C
      IF(VOM .GT. 11.5) GO TO 8
      PROD = 0.0028 * BA + 0.04355 * VOM * VOM - 2.78326
      GO TO 10
    8 PROD = 0.83943 + 0.20531 * VOM
   10 RETURN
      END
```

```
      SUBROUTINE SWCUT1
C
C TO ESTIMATE INCREASE IN AVERAGE D.B.H. DUE TO THINNING SOUTHWESTERN
C PONDEROSA PINE IF DWARF MISTLETOE RATING EQUALS ZERO.
C
      COMMON BA,BAST,OBHO,OBHT,DENO,OMR,OMRT,FCTR,PRET,PROD,REST,VOM
C
      IF(DBHO .LT. 9.5) GO TO 30
C
C COMPUTE D.B.H. IF DBHO IS LARGE ENOUGH FOR BASAL AREA TO REMAIN CONSTANT.
C
      PRET = 100.0
      DO 21 KJ=1,100
      IF(PRET .LT. 50.0) GO TO 5
      OBHE = 0.73365 + 1.02008 * OBHO - 0.01107 * (PRET - 50.0) - 0.0001
     14 * (PRET - 50.0) * (PRET - 50.0)
      GO TO 11
    5 POBHE = 0.49401 + 0.71890 * ALOG10(OBHO) - 0.22530 * ALOG10(PRET)
     1 + 0.12616 * ALOG10(OBHO) * ALOG10(PRET)
      DBHE = 10.0 ** PDBHE
   11 IOBHE = OBHE  * 10.0 + 0.5
      OBHE = IOBHE
      OBHE = DBHE * 0.1
      OENE = DENO * PRET * 0.01
      NDENE = OENE + 0.5
      DENE = NDENE
      BASE = 0.0054542 * DBHE * OBHE * OENE
      NBASE = BASE * 10.0 + 0.5
      BASE = NBASE
      BASE = BASE * 0.1
      TMPY = 0.0054542 * OBHE * OBHE
      TEM = BASE - REST
      IF(TEM .LE. TMPY) GO TO 70
      IF(TEM .LT. 4.0) GO TO 20
      PRET = PRET - 1.0
      GO TO 21
   20 PRET = PRET - 0.3
   21 CONTINUE
      GO TO 70
C
C COMPUTE O.B.H. IF BASAL AREA INCREASES WITH O.B.H.
C
   30 PRET = 40.0
      IF(OBHO .GT. 7.0) PRET = 70.0
      DO 65 J=1,100
      IF(PRET .GE. 50.0) GO TO 40
      PDBHE = 0.49401 + 0.71890 * ALOG10(OBHO) - 0.22530 * ALOG10(PRET)
     1 + 0.12616 * ALOG10(OBHO) * ALOG10(PRET)
      DBHE = 10.0 ** PDBHE
      GO TO 45
   40 DBHE = 0.73365 + 1.02008 * DBHO - 0.01107 * (PRET - 50.0) - 0.0001
     14 * (PRET - 50.0) * (PRET - 50.0)
   45 IDBHE = OBHE * 10.0 + 0.5
      OBHE = IOBHE
      DBHE = DBHE * 0.1
      OENE = DENO * (PRET * 0.01)
      NDENE = OENE + 0.5
      DENE = NDENE
      BASE = 0.0054542 * OBHE * OBHE * DENE
      NBASE = BASE * 10.0 + 0.5
      BASE = NBASE
      BASE = BASE * 0.1
      BREAK = 49.9 * REST / BO.0
      IF(BASE .GT. BREAK) GO TO 50
      OBHP = (80.0 / REST) * (0.08682 * BASE) + 0.94636
      GO TO 52
   50 BUST = 66.2 * (REST / 80.0)
      IF(BASE .GT. BUST) GO TO 51
      OBHP = (80.0 / REST) * (0.1093B * BASE) - 0.17858
      GO TO 52
   51 TMPY = BASE * (80.0 / REST)
      TEM = TMPY * TMPY
      DBHP = 19.04740 * TMPY - 0.26673 * TEM + 0.0012539 * TEM * TMPY
     1 - 448.76833
      IF(TMPY .GT. 80.0) DBHP = OBHO + 0.8
   52 IOBHP = DBHP * 10.0 + 0.5
      DBHP = IOBHP
      DBHP = DBHP * 0.1
      IF(DBHP - OBHE) 60,70,61
   60 PRET = PRET * 1.02
      GO TO 65
   61 PRET = PRET * 0.98
   65 CONTINUE
   70 OBHT = OBHE
C
C COMPUTE POST-THINNING BASAL AREA.
C
      IF(DBHT .GT. 5.0) GO TO 75
      SQFT = 11.58495 * OBHT - 11.09724
      GO TO 76
   75 IF(DBHT .GE. 10.0) GO TO 77
      TEM = DBHT * DBHT
      SQFT = 7.76226 * OBHT +0.85289 * TEM -0.07952 * TEM * DBHT-3.45624
   76 BAST = (REST / 80.0) * SQFT
      GO TO 80
   77 BAST = REST
   80 RETURN
      END
```

```
      SUBROUTINE SWCUT2
C
C TO ESTIMATE INCREASE IN AVERAGE D.B.H. DUE TO THINNING SOUTHWESTERN
C PONDEROSA PINE IF DWARF MISTLETOE RATING DETERMINES THE STANDARDS.
C
      COMMON BA,BAST,OBHO,OBHT,DENO,OMR,OMRT,FCTR,PRET,PROD,REST,VOM
C
C COMPUTE STAND DENSITY AFTER A THINNING THAT REDUCES THE INDEX.
C
      IF(OMR .LT. 2.0) GO TO 5
      REOT = 77.5 - 8.5 * OBHO + 10.0 * OMR
      GO TO 10
    5 REOT = 15.5 - 8.5 * OBHO + 41.0 * OMR
   10 PRET = 100.0 - REOT
      DENT = OENO * (PRET * 0.01)
      IDENT = OENT + 0.5
      OENT = IDENT
C
C COMPUTE D.B.H. AFTER THINNING TO DESIRED DENSITY.
C
      IF(PRET .LT. 50.0) GO TO 15
      OBHT = 0.98543 * OBHO + 0.00807 * (PRET - 50.0) + 0.00025 * (PRET
     1 - 50.0) * (PRET - 50.0) - 0.91172
      GO TO 20
   15 DBHT = 0.51618 * ALOG10(PRET) + 1.69219 * ALOG10(DBHO) - 0.34768 *
     1ALOG10(PRET) * ALOG10(OBHO) - 1.03421
      DBHT = 10.0 ** OBHT
   20 IOBHT = DBHT * 10.0 + 0.5
      DBHT = IOBHT
      DBHT = DBHT * 0.1
      BAST = 0.00545 42 * OBHT * DBHT * DENT
      RETURN
      END
```

```
      SUBROUTINE SWCUT3
C
C TO ESTIMATE INCREASE IN AVERAGE D.B.H. DUE TO THINNING FROM BELOW IF
C DWARF MISTLETOE RATING IS GREATER THAN ZERO.
C
      COMMON BA,BAST,DBHO,DBHT,DENO,DMR,DMRT,FCTR,PRET,PROD,REST,VOM
      IF(DBHO .LT. 9.5) GO TO 30
C
C COMPUTE D.B.H. IF DBHO IS LARGE ENOUGH FOR BASAL AREA TO REMAIN CONSTANT.
C
      PRFT = 100.0
      DO 21 KJ=1,100
      IF(PRET .LT. 50.0) GO TO 5
      DBHE = 0.73365 + 1.02008 * DBHO - 0.01107 * (PRET - 50.0) - 0.0001
     14 * (PRET - 50.0) * (PRET - 50.0)
      GO TO 11
    5 POBHE = 0.49401 + 0.71890 * ALOG10(DBHO) - 0.22530 * ALOG10(PRET)
     1 + 0.12616 * ALOG10(DBHO) * ALOG10(PRET)
      DBHE = 10.0 ** POBHE
   11 TEM = DBHE - DBHO
      DBHE = DBHO + TEM * 0.5
      IDBHE = DBHE * 10.0 + 0.5
      DBHE = IDBHE
      DBHE = DBHE * 0.1
      DENE = DENO * PRET * 0.01
      NOENE = DENE + 0.5
      DENE = NOENE
      BASE = 0.0054542 * DBHE * DBHE * DENE
      NBASE = BASE * 10.0 + 0.5
      BASE = NBASE
      BASE = BASE * 0.1
      TMPY = 0.0054542 * DBHE * DBHE
      TEM = BASE - REST
      IF(TEM .LE. TMPY) GO TO 70
      IF(TEM .LT. 4.0) GO TO 20
      PRET = PRET - 1.0
      GO TO 21
   20 PRET = PRET - 0.3
   21 CONTINUE
      GO TO 70
C
C COMPUTE D.B.H. IF BASAL AREA INCREASES WITH D.B.H.
C
   30 PRET = 40.0
      IF(DBHO .GT. 7.0) PRET = 70.0
      DO 65 J=1,100
      IF(PRET .GE. 50.0) GO TO 40
      POBHE = 0.49401 + 0.71890 * ALOG10(DBHO) - 0.22530 * ALOG10(PRET)
     1 + 0.12616 * ALOG10(DBHO) * ALOG10(PRET)
      DBHE = 10.0 ** POBHE
      GO TO 45
   40 DBHE = 0.73365 + 1.02008 * DBHO - 0.01107 * (PRET - 50.0) - 0.0001
     14 * (PRET - 50.0) * (PRET - 50.0)
   45 TEM = DBHE - DBHO
      DBHE = DBHO + TEM * 0.5
      IDBHE = DBHE * 10.0 + 0.5
      DBHE = IDBHE
      DBHE = DBHE * 0.1
      DENE = DENO * (PRET * 0.01)
      NOENE = DENE + 0.5
      DENE = NOENE
      BASE = 0.0054542 * DBHE * DBHE * DENE
      NBASE = BASE * 10.0 + 0.5
      BASE = NBASE
      BASE = BASE * 0.1
      BREAK = 49.9 * REST / 80.0
      IF(BASE .GT. BREAK) GO TO 50
      DBHP = (80.0 / REST) * (0.08682 * BASE) + 0.94636
      GO TO 52
   50 BUST = 66.2 * (REST / 80.0)
      IF(BASE .GT. BUST) GO TO 51
      DBHP = (80.0 / REST) * (0.10938 * BASE) - 0.17858
      GO TO 52
   51 TMPY = BASE * (80.0 / REST)
      TEM = TMPY * TMPY
      DBHP = 19.04740 * TMPY - 0.26673 * TEM + 0.0012539 * TEM * TMPY
     1 - 448.76833
      IF(TMPY .GT. 80.0) DBHP = DBHO + 0.8
   52 IDBHP = DBHP * 10.0 + 0.5
      DBHP = IDBHP
      DBHP = DBHP * 0.1
      IF(DBHP - DBHE) 60,70,61
   60 PRET = PRET * 1.02
      GO TO 65
   61 PRET = PRET * 0.98
   65 CONTINUE
   70 DBHT = DBHE
C
C COMPUTE POST-THINNING BASAL AREA.
C
      IF(DBHT .GT. 5.0) GO TO 75
      SQFT = 11.58495 * DBHT - 11.09724
      GO TO 76
   75 IF(DBHT .GE. 10.0) GO TO 77
      TEM = DBHT * DBHT
      SQFT = 7.76226 * DBHT +0.85289 * TEM -0.07952 * TEM * DBHT-3.45624
   76 BAST = (REST / 80.0) * SQFT
      GO TO 80
   77 BAST = REST
   80 RETURN
      END
```

APPENDIX 2
Output of Sample Problem

YIELDS PER ACRE DF EVEN-AGED STANDS DF PDNDERDSA PINE
SITE INDEX 70
THINNING INTENSITY- INITIAL- 100. SU8SEQUENT- 80.

	ENTIRE STAND 8EFDRE AND AFTER THINNING							PERIDDIC INTERMEDIATE CUTS				
STAND AGE (YEARS)	TREES ND.	8ASAL AREA SQ.FT.	AVERAGE D.8.H. IN.	AVERAGE HEIGHT FT.	TDTAL VDLUME CU.FT.	MERCHANT-ABLE VDLUME CU.FT.	SAWTIM8ER VDLUME 8D.FT.	TREES ND.	8ASAL AREA SQ.FT.	TDTAL VDLUME CU.FT.	MERCHANT-A8LE VDLUME CU.FT.	SAWTIM8ER VDLUME 8D.FT.
30	950	119	4.8	25	1530	360	0					
30	373	68	5.8	27	810	360	0	577	51	720	0	0
40	370	96	6.9	36	1330	920	0					
50	365	121	7.8	44	1970	1560	800					
50	188	76	8.6	45	1230	1040	800	177	45	740	520	0
60	187	96	9.7	52	1730	1530	2700					
70	186	114	10.6	58	2420	2190	5900					
70	113	80	11.4	59	1730	1580	5400	73	34	690	610	500
80	113	96	12.5	65	2320	2150	7900					
90	113	112	13.5	70	2930	2740	10600					
90	72	80	14.3	70	2120	2000	8000	41	32	810	740	2600
100	72	93	15.4	75	2620	2490	10500					
110	72	106	16.4	78	3130	2990	13200					
110	22	39	18.1	80	1190	1150	5400	50	67	1940	1840	7800
120	22	47	19.7	83	1480	1430	7200					
130	22	54	21.2	86	1770	1720	9200					
						TDTAL YIELDS				6670	5430	19600

MINIMUM CUTS FDR INCLUSIDN IN TDTAL YIELDS-- 320. CU8IC FEET AND 1500. 8DARD FEET

DWARF MISTLETOE INFECTIDN DID NDT DCCUR DURING THE RDTATIDN DF 130. YEARS.

MERCH. CU. FT. - TREES 6.0 INCHES D.8.H. AND LARGER TD 4.0-INCH TDP.

8D. FT. - TREES 10.0 INCHES D.8.H. AND LARGER TD VARIA8LE TDP LIMIT.

YIELDS PER ACRE DF EVEN-AGED STANDS DF PDNDERDSA PINE
SITE INDEX 70
THINNING INTENSITY- INITIAL- 100. SU8SEQUENT- 90.

	ENTIRE STAND 8EFDRE AND AFTER THINNING							PERIDDIC INTERMEDIATE CUTS				
STAND AGE (YEARS)	TREES ND.	8ASAL AREA SQ.FT.	AVERAGE D.8.H. IN.	AVERAGE HEIGHT FT.	TDTAL VDLUME CU.FT.	MERCHANT-A8LE VDLUME CU.FT.	SAWTIM8ER VDLUME 8D.FT.	TREES ND.	8ASAL AREA SQ.FT.	TDTAL VOLUME CU.FT.	MERCHANT-A8LE VDLUME CU.FT.	SAWTIM8ER VDLUME 8D.FT.
30	950	119	4.8	25	1530	360	0					
30	373	68	5.8	27	810	360	0	577	51	720	0	0
40	370	96	6.9	36	1330	920	0					
50	365	121	7.8	44	1970	1560	900					
50	211	85	8.6	45	1380	1170	900	154	36	590	390	0
60	210	106	9.6	52	1910	1690	2900					
70	209	126	10.5	58	2670	2420	6300					
70	129	90	11.3	59	1940	1780	5900	80	36	730	640	400
80	129	106	12.3	65	2560	2370	8600					
90	129	123	13.2	70	3200	2990	11400					
90	84	90	14.0	70	2370	2230	8800	45	33	830	760	2600
100	84	103	15.0	75	2900	2740	11400					
110	84	116	15.9	78	3430	3260	14100					
110	27	46	17.6	80	1390	1330	6200	57	70	2040	1930	7900
120	27	54	19.1	83	1700	1640	8100					
130	27	62	20.5	86	2030	1970	10200					
						TDTAL YIELDS				6940	5690	20700

MINIMUM CUTS FDR INCLUSIDN IN TDTAL YIELDS-- 320. CU8IC FEET AND 1500. 8DARD FEET

DWARF MISTLETDE INFECTIDN DID NDT DCCUR DURING THE RDTATIDN DF 130. YEARS.

MERCH. CU. FT. - TREES 6.0 INCHES D.8.H. AND LARGER TD 4.0-INCH TOP.

8D. FT. - TREES 10.0 INCHES D.8.H. AND LARGER TD VARIA8LE TDP LIMIT.

YIELDS PER ACRE OF EVEN-AGED STANDS OF PONDEROSA PINE
SITE INDEX 70
THINNING INTENSITY- INITIAL- 100. SUBSEQUENT- 100.

	ENTIRE STAND BEFORE AND AFTER THINNING							PERIODIC INTERMEDIATE CUTS				
STAND AGE (YEARS)	TREES NO.	BASAL AREA SQ.FT.	AVERAGE D.B.H. IN.	AVERAGE HEIGHT FT.	TOTAL VOLUME CU.FT.	MERCHANT-ABLE VOLUME CU.FT.	SAWTIMBER VOLUME BD.FT.	TREES NO.	BASAL AREA SQ.FT.	TOTAL VOLUME CU.FT.	MERCHANT-ABLE VOLUME CU.FT.	SAWTIMBER VOLUME BD.FT.
30	950	119	4.8	25	1530	360	0					
30	373	68	5.8	27	810	360	0	577	51	720	0	0
40	370	96	6.9	36	1330	920	0					
50	365	121	7.8	44	1970	1560	1000					
50	239	94	8.5	45	1530	1290	1000	126	27	440	270	0
60	237	114	9.4	51	2060	1820	2900					
70	235	133	10.2	58	2820	2540	6000					
70	154	100	10.9	59	2140	1950	5700	81	33	680	590	300
80	154	117	11.8	65	2800	2570	9100					
90	154	133	12.6	69	3460	3210	11900					
90	104	100	13.3	70	2630	2460	9400	50	33	830	750	2500
100	104	114	14.2	74	3200	3010	12000					
110	104	129	15.1	78	3810	3600	15000					
110	32	49	16.8	80	1490	1420	6400	72	80	2320	2180	8600
120	32	58	18.3	83	1840	1770	8500					
130	32	68	19.7	86	2210	2140	10800					
						TOTAL YIELDS				7200	5660	21900

MINIMUM CUTS FOR INCLUSION IN TOTAL YIELDS-- 320. CUBIC FEET AND 1500. BOARD FEET

DWARF MISTLETOE INFECTION DID NOT OCCUR DURING THE ROTATION OF 130. YEARS.

MERCH. CU. FT. - TREES 6.0 INCHES D.B.H. AND LARGER TO 4.0-INCH TOP.

BD. FT. - TREES 10.0 INCHES D.B.H. AND LARGER TO VARIABLE TOP LIMIT.

YIELDS PER ACRE OF EVEN-AGED STANDS OF PONDEROSA PINE
SITE INDEX 70
THINNING INTENSITY- INITIAL- 100. SUBSEQUENT- 80.

	ENTIRE STAND BEFORE AND AFTER THINNING							PERIODIC INTERMEDIATE CUTS				
STAND AGE (YEARS)	TREES NO.	BASAL AREA SQ.FT.	AVERAGE D.B.H. IN.	AVERAGE HEIGHT FT.	TOTAL VOLUME CU.FT.	MERCHANT-ABLE VOLUME CU.FT.	SAWTIMBER VOLUME BD.FT.	TREES NO.	BASAL AREA SQ.FT.	TOTAL VOLUME CU.FT.	MERCHANT-ABLE VOLUME CU.FT.	SAWTIMBER VOLUME BD.FT.
30	950	119	4.8	25	1510	0	0					
30	374	28	3.7	23	410	0	0	576	91	1100	0	0
40	372	59	5.4	32	820	290	0					
50	332	79	6.6	40	1230	800	0					
50	253	64	6.8	41	1000	670	0	79	15	230	130	0
60	227	79	8.0	47	1350	1090	300					
70	191	86	9.1	54	1630	1420	1700					
70	191	86	9.1	54	1630	1420	1700	0	0	0	0	0
80	156	87	10.1	60	1860	1670	3500					
90	124	83	11.1	64	1960	1790	5500					
90	124	83	11.1	64	1960	1790	5500	0	0	0	0	0
100	95	76	12.1	68	1920	1770	6400					
110	71	66	13.1	72	1780	1660	6300					
110	37	40	14.0	73	1080	1010	4000	34	26	700	650	2300
120	29	38	15.5	76	1090	1030	4400					
130	21	33	16.9	79	970	1010	4200					
						TOTAL YIELDS				3000	1660	6500

MINIMUM CUTS FOR INCLUSION IN TOTAL YIELDS-- 320. CUBIC FEET AND 1500. BOARD FEET

DWARF MISTLETOE INFECTION STARTED AT AGE 10. AND RATING WAS 6.0 AT AGE 130.

NOTE THAT NOT ALL SCHEDULED THINNINGS WERE POSSIBLE.

MERCH. CU. FT. - TREES 6.0 INCHES D.B.H. AND LARGER TO 4.0-INCH TOP.

BD. FT. - TREES 10.0 INCHES D.B.H. AND LARGER TO VARIABLE TOP LIMIT.

YIELDS PER ACRE OF EVEN-AGED STANDS OF PONDEROSA PINE
SITE INDEX 70
THINNING INTENSITY- INITIAL- 100. SUBSEQUENT- 90.

	ENTIRE STAND BEFORE AND AFTER THINNING							PERIODIC INTERMEDIATE CUTS				
STAND AGE (YEARS)	TREES NO.	BASAL AREA SQ.FT.	AVERAGE D.B.H. IN.	AVERAGE HEIGHT FT.	TOTAL VOLUME CU.FT.	MERCHANTABLE VOLUME CU.FT.	SAWTIMBER VOLUME BD.FT.	TREES NO.	BASAL AREA SQ.FT.	TOTAL VOLUME CU.FT.	MERCHANTABLE VOLUME CU.FT.	SAWTIMBER VOLUME BD.FT.
30	950	119	4.8	25	1510	0	0					
30	374	28	3.7	23	410	0	0	576	91	1100	0	0
40	372	59	5.4	32	820	290	0					
50	332	79	6.6	40	1230	800	0					
50	289	71	6.7	41	1100	730	0	43	8	130	70	0
60	256	85	7.8	47	1450	1150	0					
70	215	91	8.8	54	1720	1480	1500					
70	215	91	8.8	54	1720	1480	1500	0	0	0	0	0
80	175	92	9.8	59	1950	1740	3200					
90	138	88	10.8	64	2060	1870	5200					
90	138	88	10.8	64	2060	1870	5200	0	0	0	0	0
100	106	81	11.8	68	2030	1870	6600					
110	79	71	12.8	72	1880	1750	6500					
110	44	45	13.7	73	1220	1140	4500	35	26	660	610	2000
120	34	42	15.1	76	1200	1140	4700					
130	25	37	16.4	78	1090	1140	4600					
						TOTAL YIELDS				2980	1750	6600

MINIMUM CUTS FOR INCLUSION IN TOTAL YIELDS-- 320. CUBIC FEET AND 1500. BOARD FEET

DWARF MISTLETOE INFECTION STARTED AT AGE 10. AND RATING WAS 6.0 AT AGE 130.

NOTE THAT NOT ALL SCHEDULED THINNINGS WERE POSSIBLE.

MERCH. CU. FT. - TREES 6.0 INCHES D.B.H. AND LARGER TO 4.0-INCH TOP.

BD. FT. - TREES 10.0 INCHES D.B.H. AND LARGER TO VARIABLE TOP LIMIT.

YIELDS PER ACRE OF EVEN-AGED STANDS OF PONDEROSA PINE
SITE INDEX 70
THINNING INTENSITY- INITIAL- 100. SUBSEQUENT- 100.

	ENTIRE STAND BEFORE AND AFTER THINNING							PERIODIC INTERMEDIATE CUTS				
STAND AGE (YEARS)	TREES NO.	BASAL AREA SQ.FT.	AVERAGE D.B.H. IN.	AVERAGE HEIGHT FT.	TOTAL VOLUME CU.FT.	MERCHANTABLE VOLUME CU.FT.	SAWTIMBER VOLUME BD.FT.	TREES NO.	BASAL AREA SQ.FT.	TOTAL VOLUME CU.FT.	MERCHANTABLE VOLUME CU.FT.	SAWTIMBER VOLUME BD.FT.
30	950	119	4.8	25	1510	0	0					
30	374	28	3.7	23	410	0	0	576	91	1100	0	0
40	372	59	5.4	32	820	290	0					
50	332	79	6.6	40	1230	800	0					
50	327	78	6.6	40	1210	790	0	5	1	20	10	0
60	284	92	7.7	47	1570	1230	0					
70	238	98	8.7	53	1860	1590	1500					
70	238	98	8.7	53	1860	1590	1500	0	0	0	0	0
80	194	98	9.6	59	2060	1830	3100					
90	153	92	10.5	64	2140	1940	4900					
90	153	92	10.5	64	2140	1940	4900	0	0	0	0	0
100	117	83	11.4	68	2080	1900	6500					
110	87	73	12.4	71	1940	1790	6600					
110	53	50	13.2	72	1360	1270	4800	34	23	580	520	1800
120	41	47	14.5	75	1330	1250	5100					
130	30	41	15.8	78	1200	1270	4900					
						TOTAL YIELDS				2900	1790	6700

MINIMUM CUTS FOR INCLUSION IN TOTAL YIELDS-- 320. CUBIC FEET AND 1500. BOARD FEET

DWARF MISTLETOE INFECTION STARTED AT AGE 10. AND RATING WAS 6.0 AT AGE 130.

NOTE THAT NOT ALL SCHEDULED THINNINGS WERE POSSIBLE.

MERCH. CU. FT. - TREES 6.0 INCHES D.B.H. AND LARGER TO 4.0-INCH TOP.

BD. FT. - TREES 10.0 INCHES D.B.H. AND LARGER TO VARIABLE TOP LIMIT.

YIELDS PER ACRE OF EVEN-AGED STANDS OF PONDEROSA PINE
SITE INDEX 70
THINNING INTENSITY- INITIAL- 100. SUBSEQUENT- 80.

	ENTIRE STAND BEFORE AND AFTER THINNING							PERIODIC INTERMEDIATE CUTS				
STAND AGE (YEARS)	TREES NO.	BASAL AREA SQ.FT.	AVERAGE D.B.H. IN.	AVERAGE HEIGHT FT.	TOTAL VOLUME CU.FT.	MERCHANT-ABLE VOLUME CU.FT.	SAWTIMBER VOLUME BD.FT.	TREES NO.	BASAL AREA SQ.FT.	TOTAL VOLUME CU.FT.	MERCHANT-ABLE VOLUME CU.FT.	SAWTIMBER VOLUME BD.FT.
50	575	121	6.2	40	1920	1060	0					
50	575	121	6.2	40	1920	1060	0	0	0	0	0	0
60	447	116	6.9	46	2020	1400	0					
70	337	106	7.6	53	2040	1580	0					
70	337	106	7.6	53	2040	1580	0	0	0	0	0	0
80	246	95	8.4	59	1960	1640	1100					
90	174	80	9.2	63	1810	1580	2000					
90	174	80	9.2	63	1810	1580	2000	0	0	0	0	0
100	121	67	10.1	67	1640	1470	3000					
110	85	57	11.1	71	1480	1350	4100					
110	52	40	11.9	71	1060	980	3500	33	17	420	370	600
120	40	39	13.3	75	1070	1000	3800					
130	29	34	14.7	77	990	980	3800					
						TOTAL YIELDS				1410	1350	3800

MINIMUM CUTS FOR INCLUSION IN TOTAL YIELDS-- 320. CUBIC FEET AND 1500. BOARD FEET

DWARF MISTLETOE INFECTION STARTED AT AGE 10. AND RATING WAS 6.0 AT AGE 130.

NOTE THAT NOT ALL SCHEDULED THINNINGS WERE POSSIBLE.

MERCH. CU. FT. - TREES 6.0 INCHES D.B.H. AND LARGER TO 4.0-INCH TOP.

BD. FT. - TREES 10.0 INCHES D.B.H. AND LARGER TO VARIABLE TOP LIMIT.

YIELDS PER ACRE OF EVEN-AGED STANDS OF PONDEROSA PINE
SITE INDEX 70
THINNING INTENSITY- INITIAL- 100. SUBSEQUENT- 90.

	ENTIRE STAND BEFORE AND AFTER THINNING							PERIODIC INTERMEDIATE CUTS				
STAND AGE (YEARS)	TREES NO.	BASAL AREA SQ.FT.	AVERAGE D.B.H. IN.	AVERAGE HEIGHT FT.	TOTAL VOLUME CU.FT.	MERCHANT-ABLE VOLUME CU.FT.	SAWTIMBER VOLUME BD.FT.	TREES NO.	BASAL AREA SQ.FT.	TOTAL VOLUME CU.FT.	MERCHANT-ABLE VOLUME CU.FT.	SAWTIMBER VOLUME BD.FT.
50	575	121	6.2	40	1920	1060	0					
50	575	121	6.2	40	1920	1060	0	0	0	0	0	0
60	447	116	6.9	46	2020	1400	0					
70	337	106	7.6	53	2040	1580	0					
70	337	106	7.6	53	2040	1580	0	0	0	0	0	0
80	246	95	8.4	59	1960	1640	1100					
90	174	80	9.2	63	1810	1580	2000					
90	174	80	9.2	63	1810	1580	2000	0	0	0	0	0
100	121	67	10.1	67	1640	1470	3000					
110	85	57	11.1	71	1480	1350	4100					
110	60	45	11.7	71	1180	1080	3800	25	12	300	270	300
120	45	41	13.0	74	1150	1070	4000					
130	32	36	14.3	77	1030	1080	3900					
						TOTAL YIELDS				1330	1080	3900

MINIMUM CUTS FOR INCLUSION IN TOTAL YIELDS-- 320. CUBIC FEET AND 1500. BOARD FEET

DWARF MISTLETOE INFECTION STARTED AT AGE 10. AND RATING WAS 6.0 AT AGE 130.

NOTE THAT NOT ALL SCHEDULED THINNINGS WERE POSSIBLE.

MERCH. CU. FT. - TREES 6.0 INCHES D.B.H. AND LARGER TO 4.0-INCH TOP.

BD. FT. - TREES 10.0 INCHES D.B.H. AND LARGER TO VARIABLE TOP LIMIT.

YIELOS PER ACRE OF EVEN-AGEO STANDS OF PONOEROSA PINE
SITE INOEX 70
THINNING INTENSITY- INITIAL- 100. SUBSEQUENT- 100.

	ENTIRE STANO BEFORE ANO AFTER THINNING							PERIODIC INTERMEOIATE CUTS				
STAND AGE (YEARS)	TREES NO.	BASAL AREA SQ.FT.	AVERAGE O.B.H. IN.	AVERAGE HEIGHT FT.	TOTAL VOLUME CU.FT.	MERCHANT-ABLE VOLUME CU.FT.	SAWTIMBER VOLUME BO.FT.	TREES NO.	BASAL AREA SQ.FT.	TOTAL VOLUME CU.FT.	MERCHANT-ABLE VOLUME CU.FT.	SAWTIMBER VOLUME BO.FT.
50	575	121	6.2	40	1920	1060	0					
50	575	121	6.2	40	1920	1060	0	0	0	0	0	0
60	447	116	6.9	46	202D	1400	0					
70	337	106	7.6	53	2040	15B0	0					
70	337	106	7.6	53	2040	15B0	0	0	0	0	0	0
BD	246	95	B.4	59	1960	1640	1100					
90	174	B0	9.2	63	1810	15B0	2000					
9D	174	B0	9.2	63	1810	15B0	2000	0	0	0	0	0
100	121	67	10.1	67	1640	1470	30D0					
110	B5	57	11.1	71	1480	1350	4100					
110	69	5D	11.5	71	1300	1190	4000	16	7	180	160	100
120	51	46	12.B	74	125D	1170	4400					
130	37	40	14.1	77	1150	1190	4300					
						TOTAL YIELOS				1330	1190	4300

MINIMUM CUTS FOR INCLUSION IN TOTAL YIELOS-- 320. CUBIC FEET ANO 1500. BOARD FEET

OWARF MISTLETOE INFECTION STARTEO AT AGE 10. AND RATING WAS 6.0 AT AGE 130.

NOTE THAT NOT ALL SCHEOULEO THINNINGS WERE POSSIBLE.

MERCH. CU. FT. - TREES 6.0 INCHES O.B.H. AND LARGER TO 4.0-INCH TOP.

BO. FT. - TREES 10.0 INCHES O.B.H. AND LARGER TO VARIABLE TOP LIMIT.

Myers, Clifford A., Frank G. Hawksworth, and Paul C. Lightle. 1972. Simulating yields of southwestern ponderosa pine stands, including effects of dwarf mistletoe. USDA Forest Serv. Res. Pap. RM-87, 16 p. Rocky Mt. Forest and Range Exp. Stn., Fort Collins, Colo. 80521.

Presents a procedure for computation of yield tables for diseased even-aged stands of ponderosa pine in Arizona and New Mexico. Stand age at time of initial infection by dwarf mistletoe may be varied as desired. Other control variables include stand age at initial thinning, stocking goals, frequency of thinning, and regeneration system. Stand conditions and severity of dwarf mistletoe infestation change with time and in response to intermediate cuttings.

Keywords: Stand yield tables, timber management, forest management, simulation, Arceuthobium vaginatum, Pinus ponderosa.

Myers, Clifford A., Frank G. Hawksworth, and Paul C. Lightle. 1972. Simulating yields of southwestern ponderosa pine stands, including effects of dwarf mistletoe. USDA Forest Serv. Res. Pap. RM-87, 16 p. Rocky Mt. Forest and Range Exp. Stn., Fort Collins, Colo. 80521.

Presents a procedure for computation of yield tables for diseased even-aged stands of ponderosa pine in Arizona and New Mexico. Stand age at time of initial infection by dwarf mistletoe may be varied as desired. Other control variables include stand age at initial thinning, stocking goals, frequency of thinning, and regeneration system. Stand conditions and severity of dwarf mistletoe infestation change with time and in response to intermediate cuttings.

Keywords: Stand yield tables, timber management, forest management, simulation, Arceuthobium vaginatum, Pinus ponderosa.

Myers, Clifford A., Frank G. Hawksworth, and Paul C. Lightle. 1972. Simulating yields of southwestern ponderosa pine stands, including effects of dwarf mistletoe. USDA Forest Serv. Res. Pap. RM-87, 16 p. Rocky Mt. Forest and Range Exp. Stn., Fort Collins, Colo. 80521.

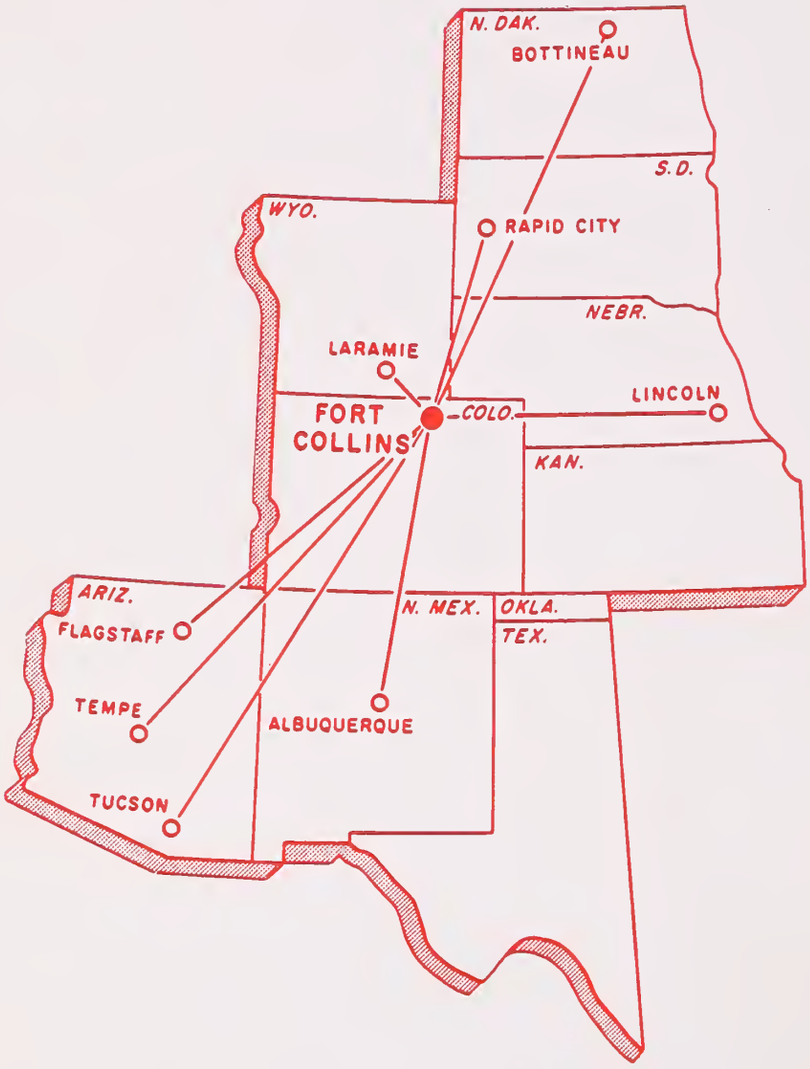
Presents a procedure for computation of yield tables for diseased even-aged stands of ponderosa pine in Arizona and New Mexico. Stand age at time of initial infection by dwarf mistletoe may be varied as desired. Other control variables include stand age at initial thinning, stocking goals, frequency of thinning, and regeneration system. Stand conditions and severity of dwarf mistletoe infestation change with time and in response to intermediate cuttings.

Keywords: Stand yield tables, timber management, forest management, simulation, Arceuthobium vaginatum, Pinus ponderosa.

Myers, Clifford A., Frank G. Hawksworth, and Paul C. Lightle. 1972. Simulating yields of southwestern ponderosa pine stands, including effects of dwarf mistletoe. USDA Forest Serv. Res. Pap. RM-87, 16 p. Rocky Mt. Forest and Range Exp. Stn., Fort Collins, Colo. 80521.

Presents a procedure for computation of yield tables for diseased even-aged stands of ponderosa pine in Arizona and New Mexico. Stand age at time of initial infection by dwarf mistletoe may be varied as desired. Other control variables include stand age at initial thinning, stocking goals, frequency of thinning, and regeneration system. Stand conditions and severity of dwarf mistletoe infestation change with time and in response to intermediate cuttings.

Keywords: Stand yield tables, timber management, forest management, simulation, Arceuthobium vaginatum, Pinus ponderosa.


N. DAK.
BOTTINEAU
S. D.
WYO.
RAPID CITY
NEBR.
LARAMIE
LINCOLN
FORT COLLINS
COLO.
KAN.
ARIZ.
N. MEX.
OKLA.
TEX.
FLAGSTAFF
TEMPE
ALBUQUERQUE
TUCSON